



***Office of the Director
Defense Research and Engineering***



***National Security Workforce:
Issues and DoD Strategies***

***Department of Education
Science Summit Briefing***

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Director of Defense Research & Engineering

***Washington, DC
March 16, 2004***

Overview



- **DoD Transformation: Capabilities-Based Approach**
- **Science and Engineering Workforce**
 - U.S.
 - Department of Defense
 - The Future
- **Summary**

Quadrennial Defense Review *

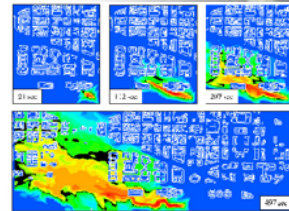
Critical Operational Goals



- **Protect Bases of Operations**
- **Conduct Information Operations**
- **Project and Sustain US Forces**
- **Deny Enemy Sanctuary**
- **Conduct Space Operations**
- **Leverage Information Technologies**

****Report to Congress: September 30, 2001***

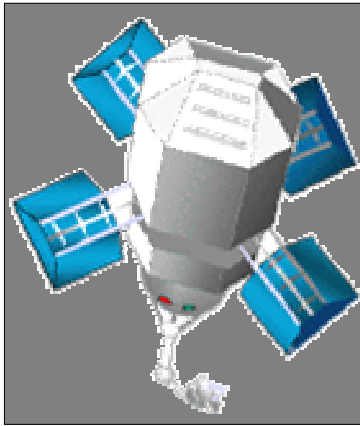
-
- A composite image featuring a portrait of Osama bin Laden in the foreground, with a large explosion and thick black smoke rising from the World Trade Center towers in the background.



Conduct Information Operations



- *Defensive IO and Information Assurance*
- *Offensive IO*



Project and Sustain US Forces



- *Anti-Access Capabilities*

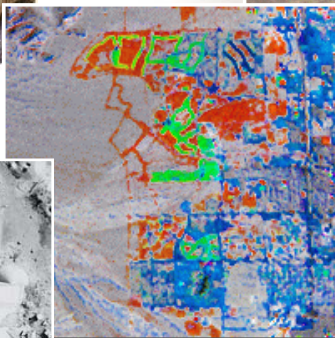
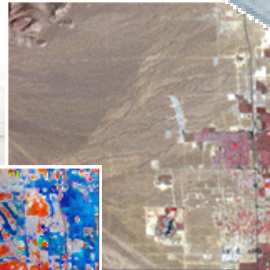
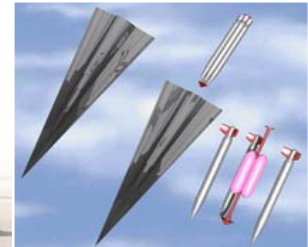


Deny Enemy Sanctuary



Persistent Surveillance, Tracking and Rapid Engagement with Precision Strike

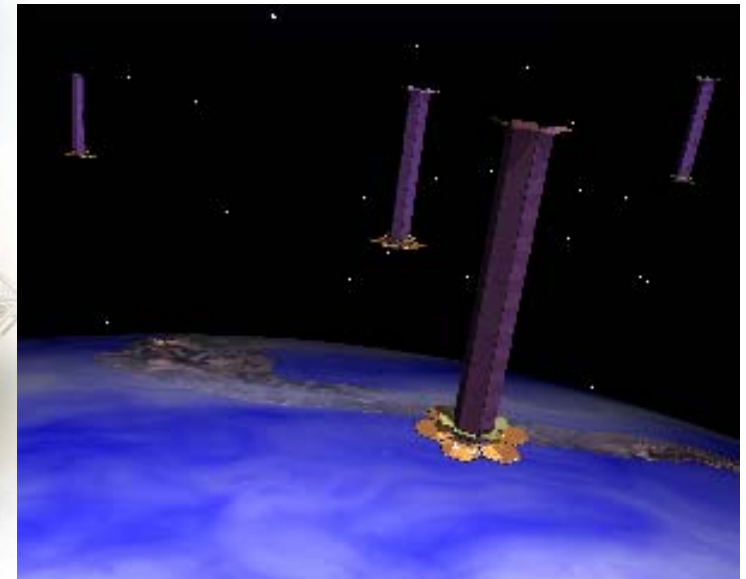
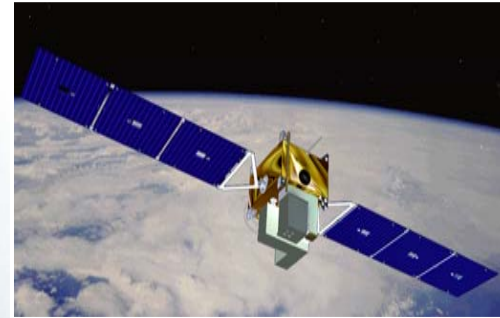
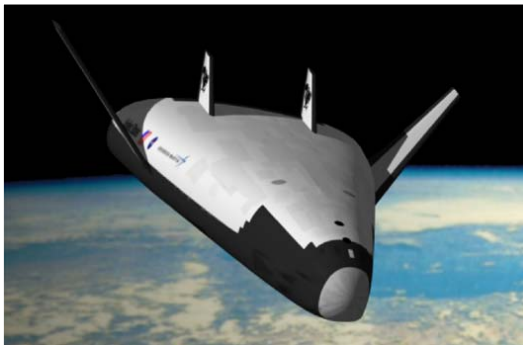
- ***Remote Sensing/Enhanced C4ISR***
- ***Unmanned Aerial Vehicle***
- ***Long-Range Precision Strike***
- ***Small-Diameter Munitions***
- ***Defeat Hard and Deeply Buried Targets***



Conduct Space Operations



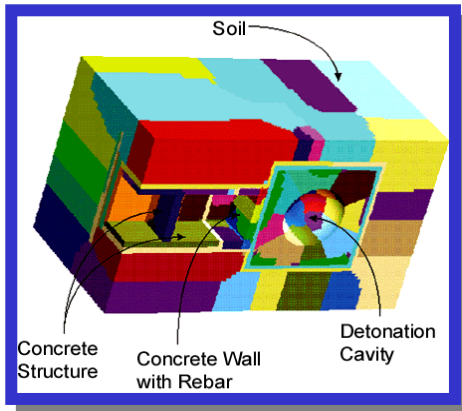
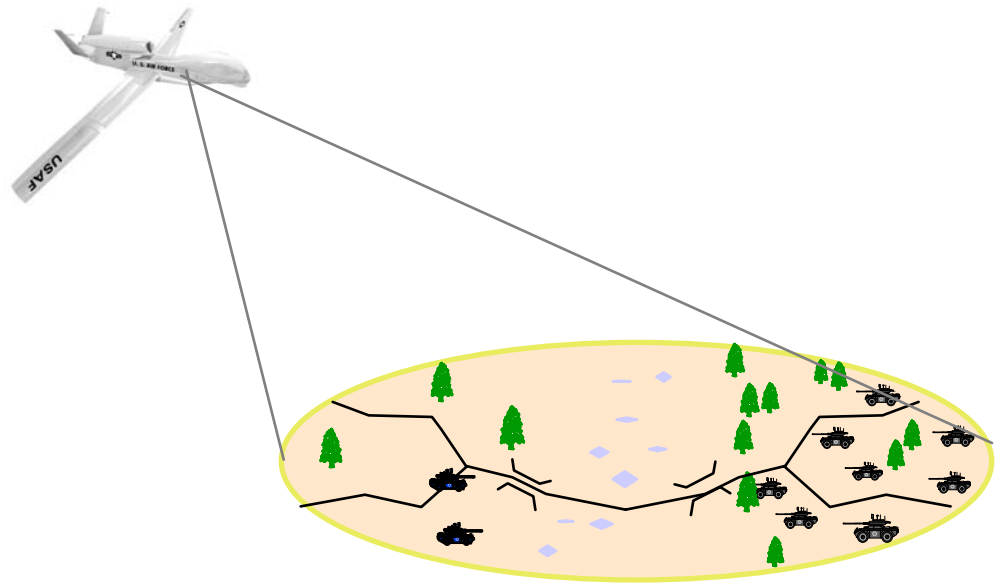
- *Ensure Access to Space*
- *Protect Space Assets*
- *Space Surveillance*
- *Control Space*
- *Sub-Orbital Space Vehicle*



Leverage Information Technologies



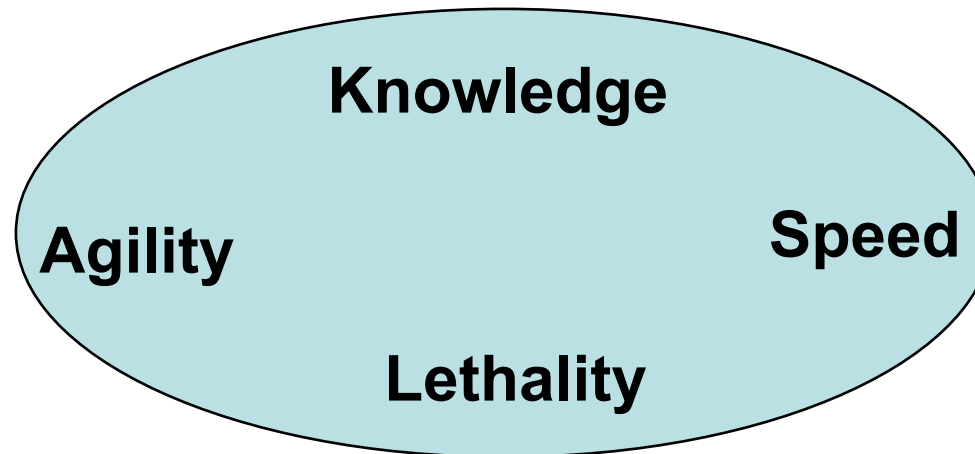
- *High-capacity Interoperable Communications*
- *Survivable, Improved, Tactical and Strategic Communications*
- *End-to-end C4ISR*



Transformation Technology Initiatives



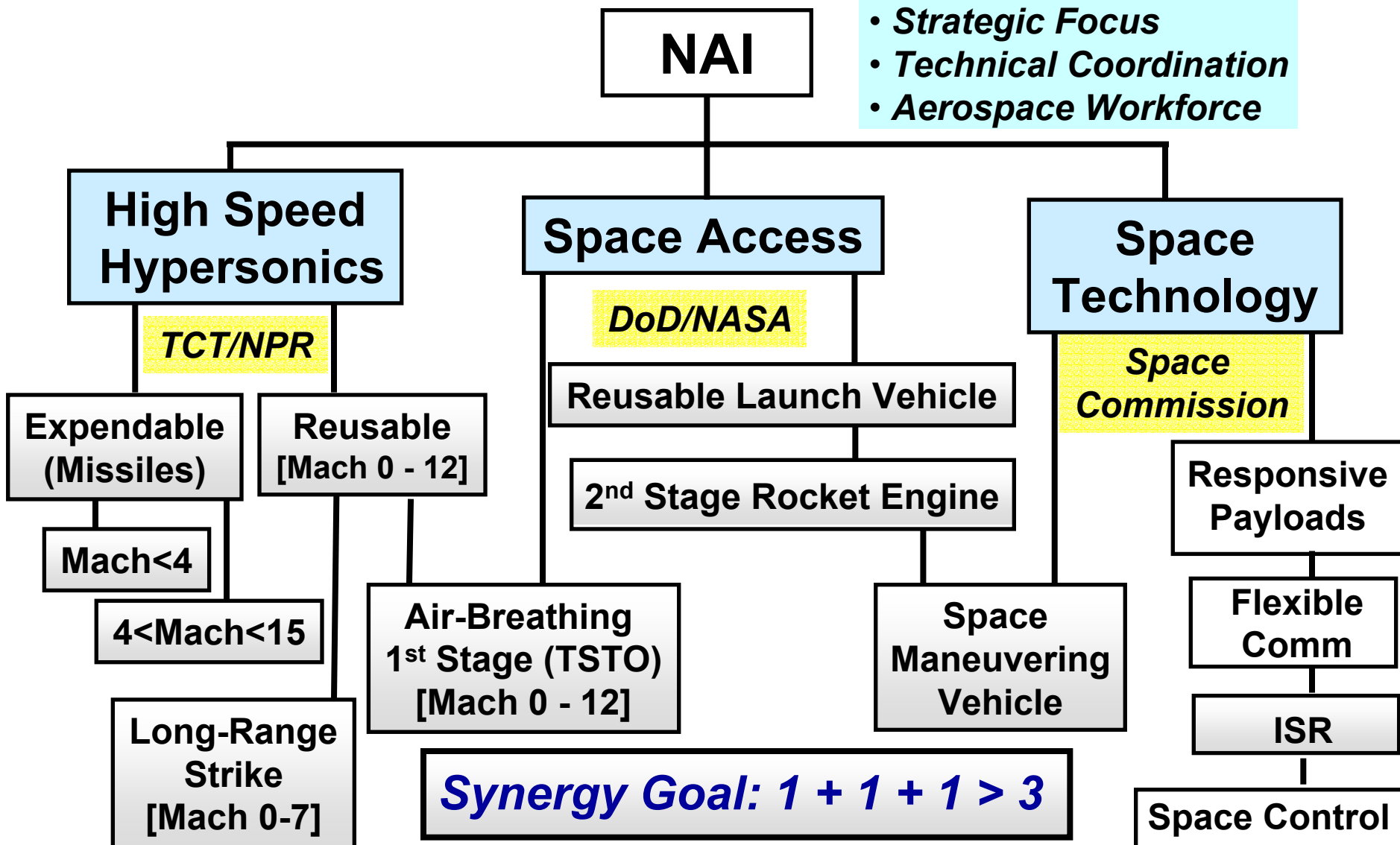
- **Transformation Attributes**



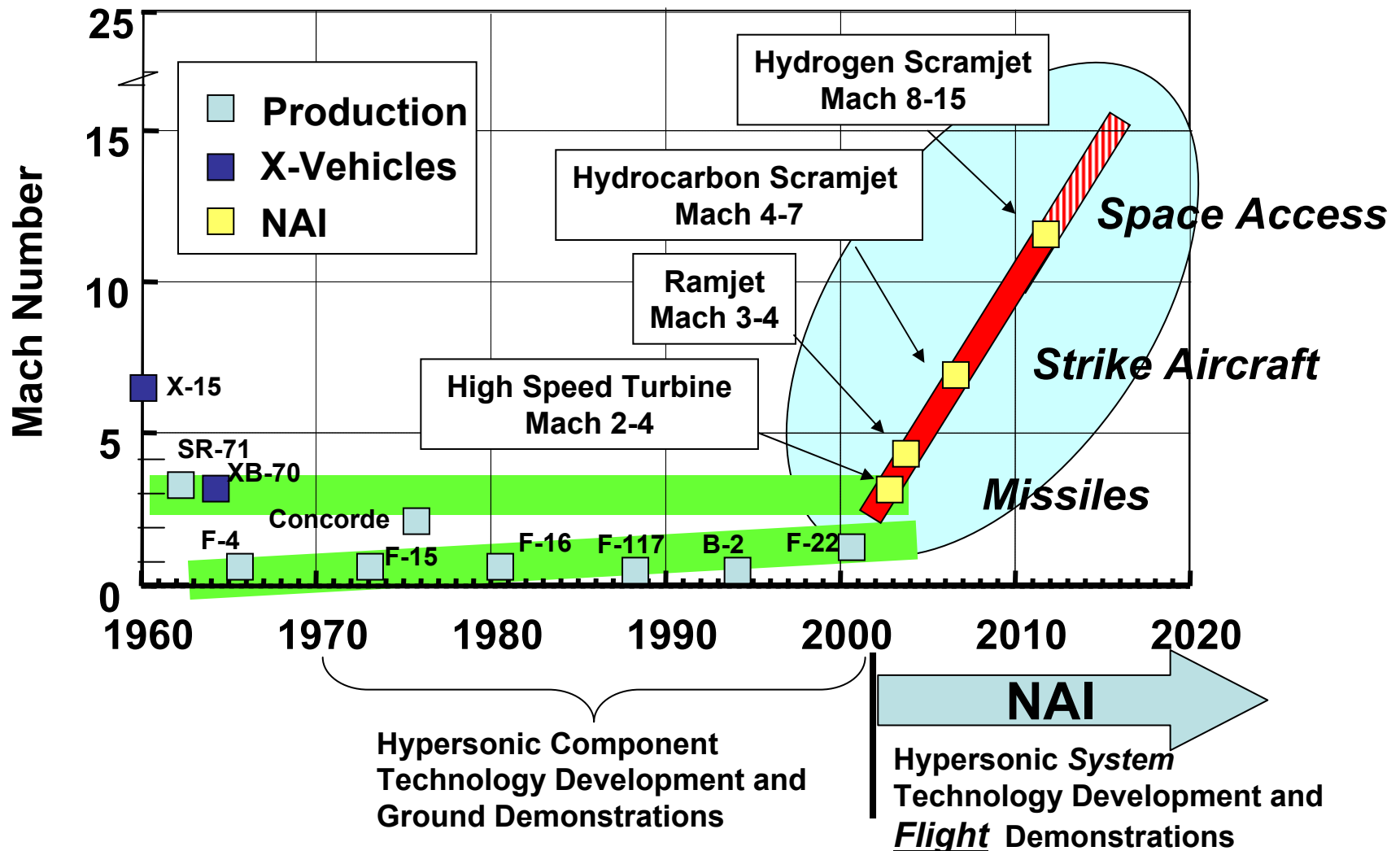
- **Transformation Technology Initiatives**
 - **National Aerospace Initiative**
 - **Energy and Power Technologies**
 - **Surveillance and Knowledge Systems**

National Aerospace Initiative

-- Technology Framework --



National Aerospace Initiative



Energy & Power Technologies...

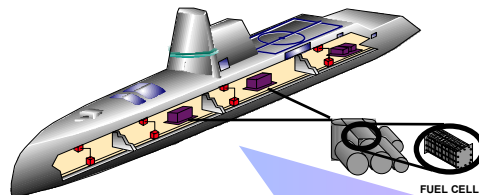
Enabling a More Electric Force



POWER GENERATION
<ul style="list-style-type: none">• Fuel Cells & Fuel Reforming• Novel Power

ENERGY STORAGE
<ul style="list-style-type: none">• Batteries• Capacitors

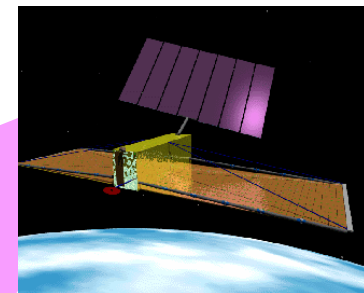
POWER CONTROL AND DISTRIBUTION
<ul style="list-style-type: none">• Switching & Conditioning• Power Transmission & Distribution• Thermal Management



Electric Warship



More Electric Aircraft



Space Based Radar

High Power Microwave



FY02

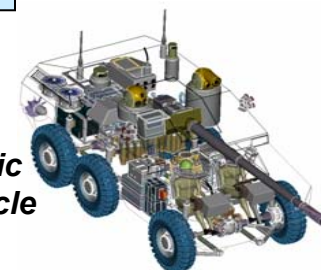
FY12

New Operational Capabilities

Electric/Hybrid Weapons

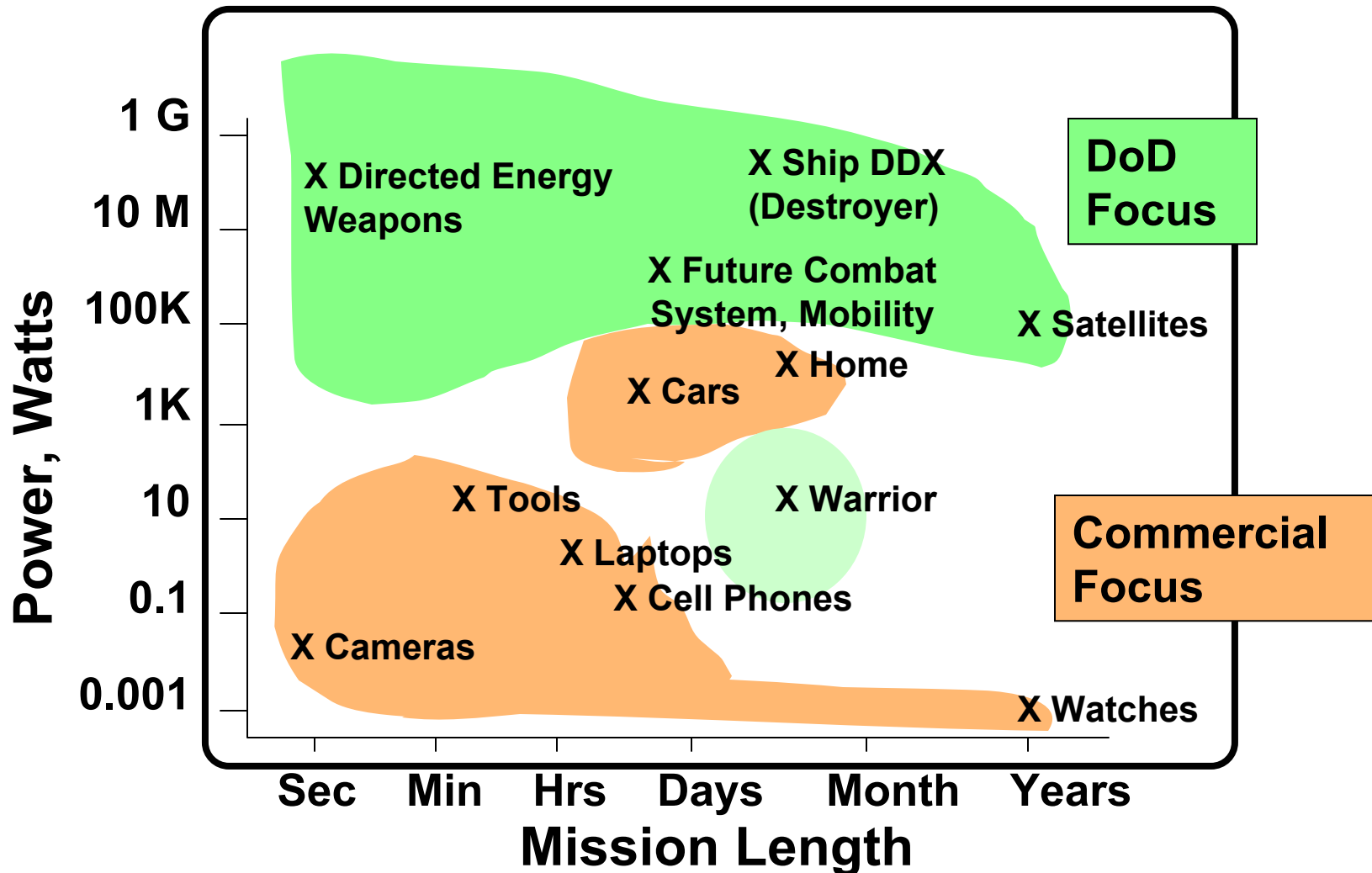


Hybrid/Electric Combat Vehicle



Warrior

Energy and Power Technologies



Surveillance & Knowledge Systems



Information and Decision Dominance achieved through integrated C4ISR technologies that enable seamless, interoperable, knowledge-based, and assured Joint & Coalition Network-Centric Operations & Warfare.

- **Sensing:**

Management and tasking of pervasive, persistent sensors for enhancing battlespace knowledge

- **Comms & Networking:**

Guaranteed, 365x24x7, mobile, information access and delivery (always-on “internet dial tone”)

- **Knowledge Management:**

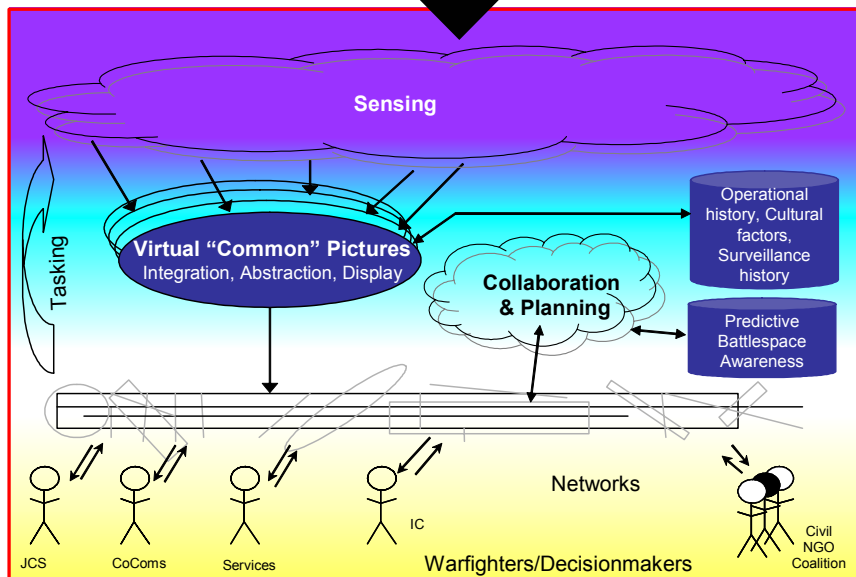
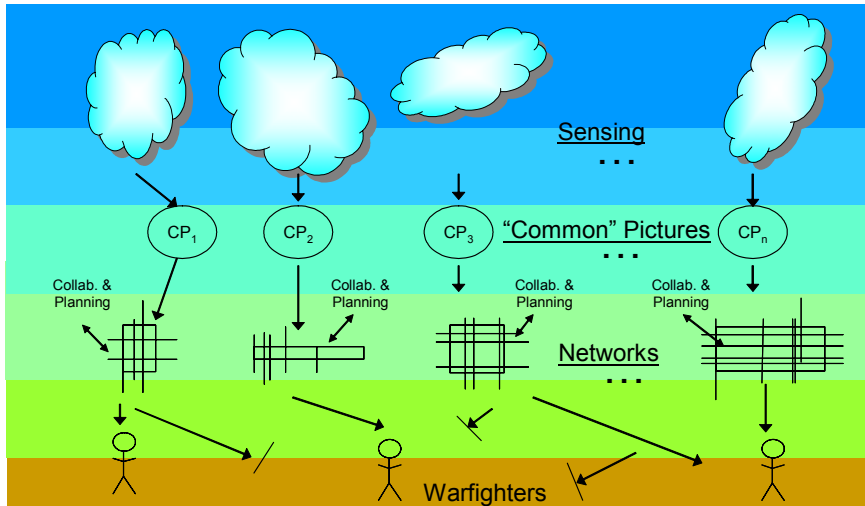
Dramatically improved speed of command through integrated Common Picture, Collaboration, and Planning

- **Information Security (Cyber Ops):**

Network protection, information assurance; offensive disruption

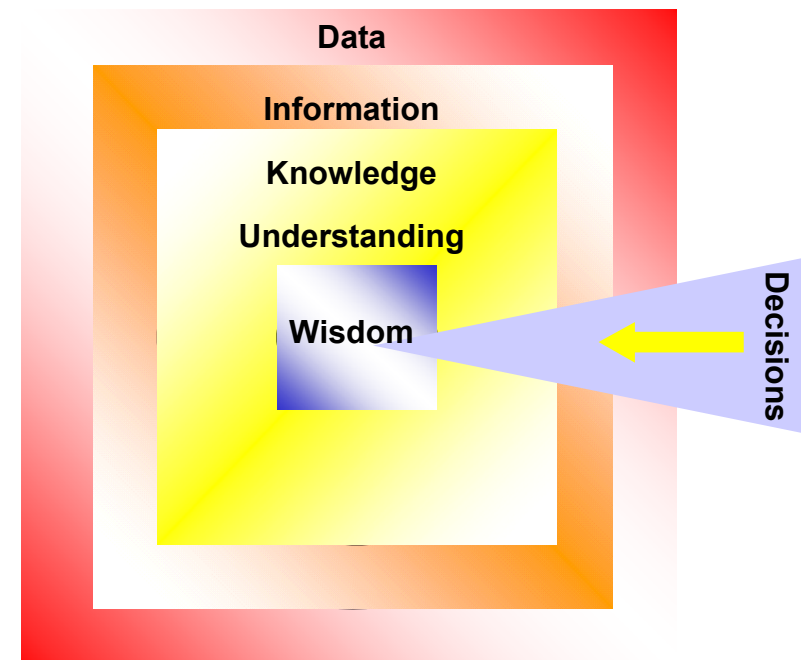
Surveillance & Knowledge

Enabling Integrated C4ISR



Technology Foci

- Adaptive Networks
- Ubiquitous Sensors
- Decision Aids





DoD S&Es as % of Fed S&E Workforce

	1994	1995	1996	1997	1998
Total S&Es	48.0%	47.6%	47.6%	46.6%	45.8%
All sci	28.8%	28.6%	28.8%	28.0%	27.4%
Comp/Math sci	54.0%	51.6%	50.4%	48.8%	47.6%
Life sci	10.8%	11.7%	12.0%	12.2%	12.0%
Physical sci	29.4%	29.2%	30.2%	28.2%	27.5%
Social sci	21.2%	21.6%	21.7%	21.9%	21.4%
All eng	67.1%	67.2%	67.7%	67.3%	67.0%
Aerospace	46.3%	45.5%	46.7%	46.7%	45.2%
Chemical	59.5%	59.6%	62.1%	61.3%	60.8%
Civil	59.7%	61.3%	62.1%	62.1%	61.8%
EE&Comp	79.0%	79.4%	79.9%	79.4%	79.4%
Industrial	86.0%	85.2%	84.8%	83.8%	82.4%
Mechanical	88.1%	88.2%	88.5%	88.2%	88.2%
Other eng	54.3%	54.0%	54.5%	54.5%	54.7%

Source: Pre-release - OPM data for NSF pub, Table B-14. Federal scientists and engineers, by agency and major occupational group: 1994-1998



DoD Percent of Federal Research

Basic and Applied Research (FY00)

	<u>Fed</u> <u>Total</u>	<u>Univ.</u> <u>Research</u>	<u>Univ.</u> <u>Basic</u>	<u>Univ.</u> <u>Applied</u>
Aeronautical	38%	52%	37%	71%
Astronautical	14%	28%	90%	3%
Electrical Engineering	81%	68%	69%	68%
Mechanical Engineering	71%	67%	67%	72%
Metallurgy & Materials	36%	37%	33%	59%
Civil Engineering	35%	14%	11%	20%
All Engineering	39%	33%	32%	36%
Mathematics	15%	14%	14%	15%
Computer Science	35%	37%	12%	88%
All Fields of Research	13%	7%	7%	8%

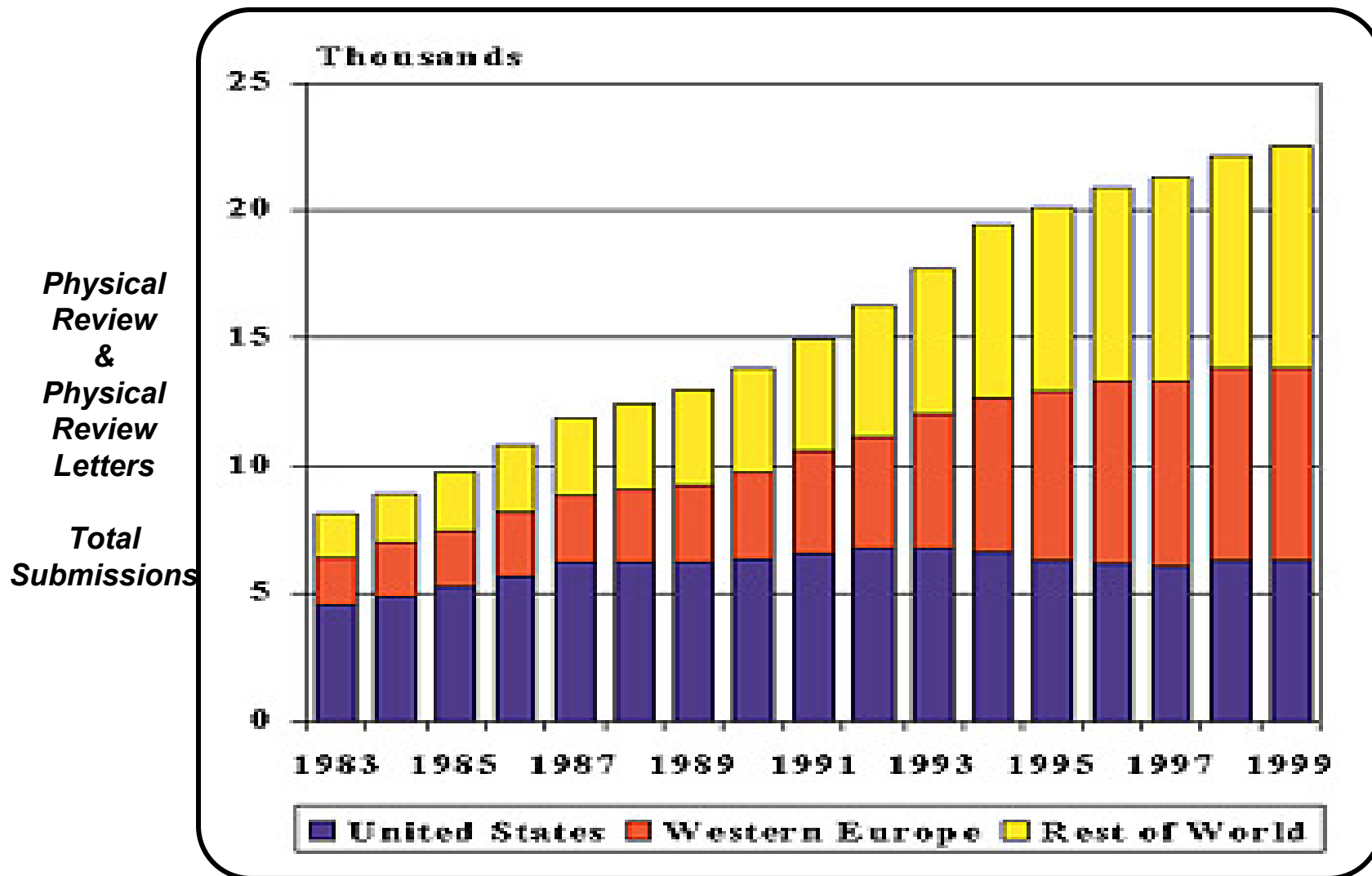
Overall S&E Demand Projections 2000-2010

From "Occupational Outlook Handbook" Bureau of Labor Statistics

DoD Defense-Related Disciplines	Projected growth in S&E Demand
Aerospace Engineering	10-20%
Chemical Engineering	3-9%
Computer Hardware Engineering	21-35%
Computer Software Engineering	36%
Electrical & Electronic Engineering	10-20%
Industrial Engineering	3-9%
Materials Engineering	3-9%
Mechanical Engineering	10-20%
Nuclear Engineering	0-2%
Mathematics	-1%
Chemistry/Materials Science	10-20%
Physics	10%



Physical Review Trends

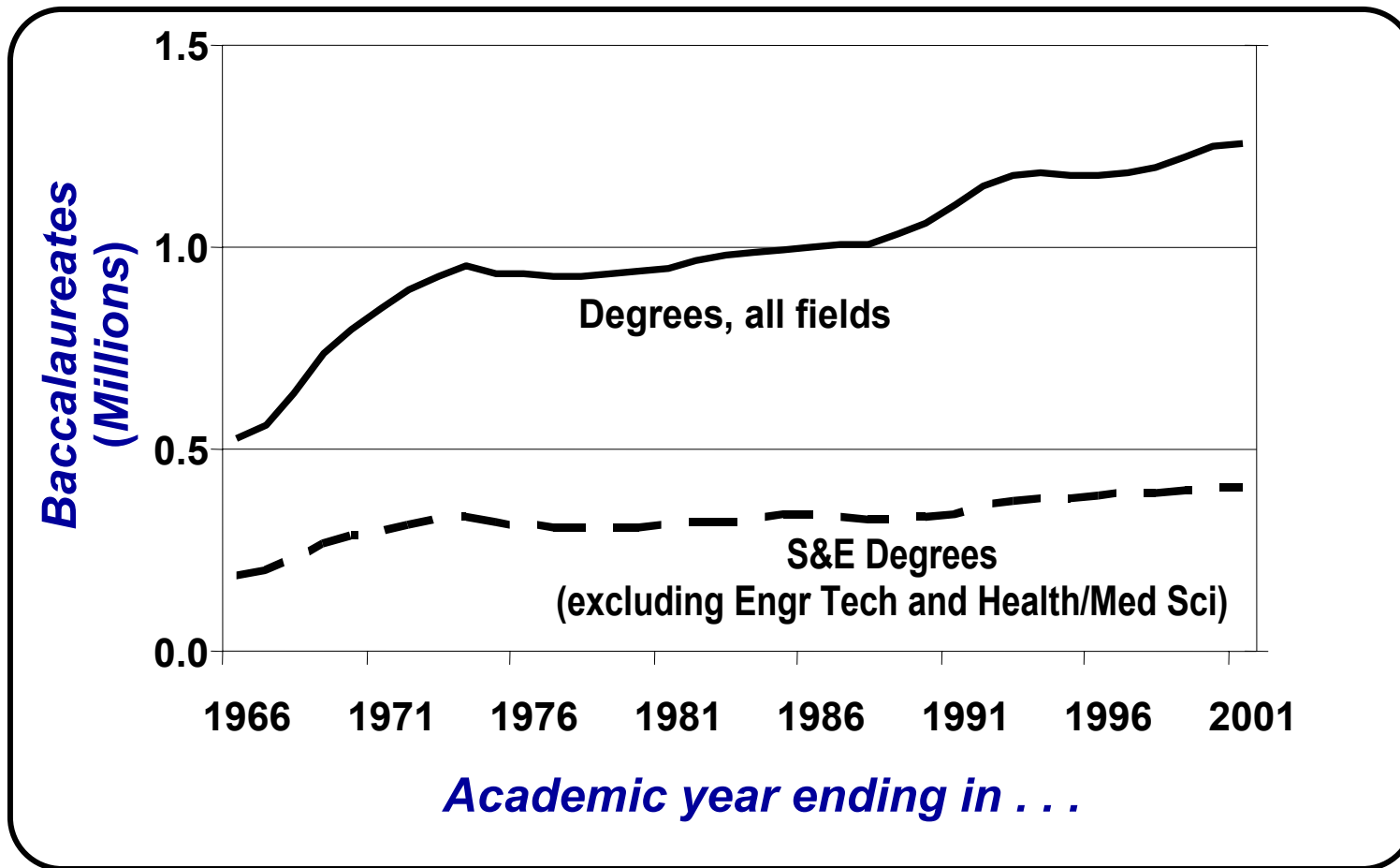


Source: American Physical Society - APS News August/September 2000 -

U.S. Production of S&E Graduates*



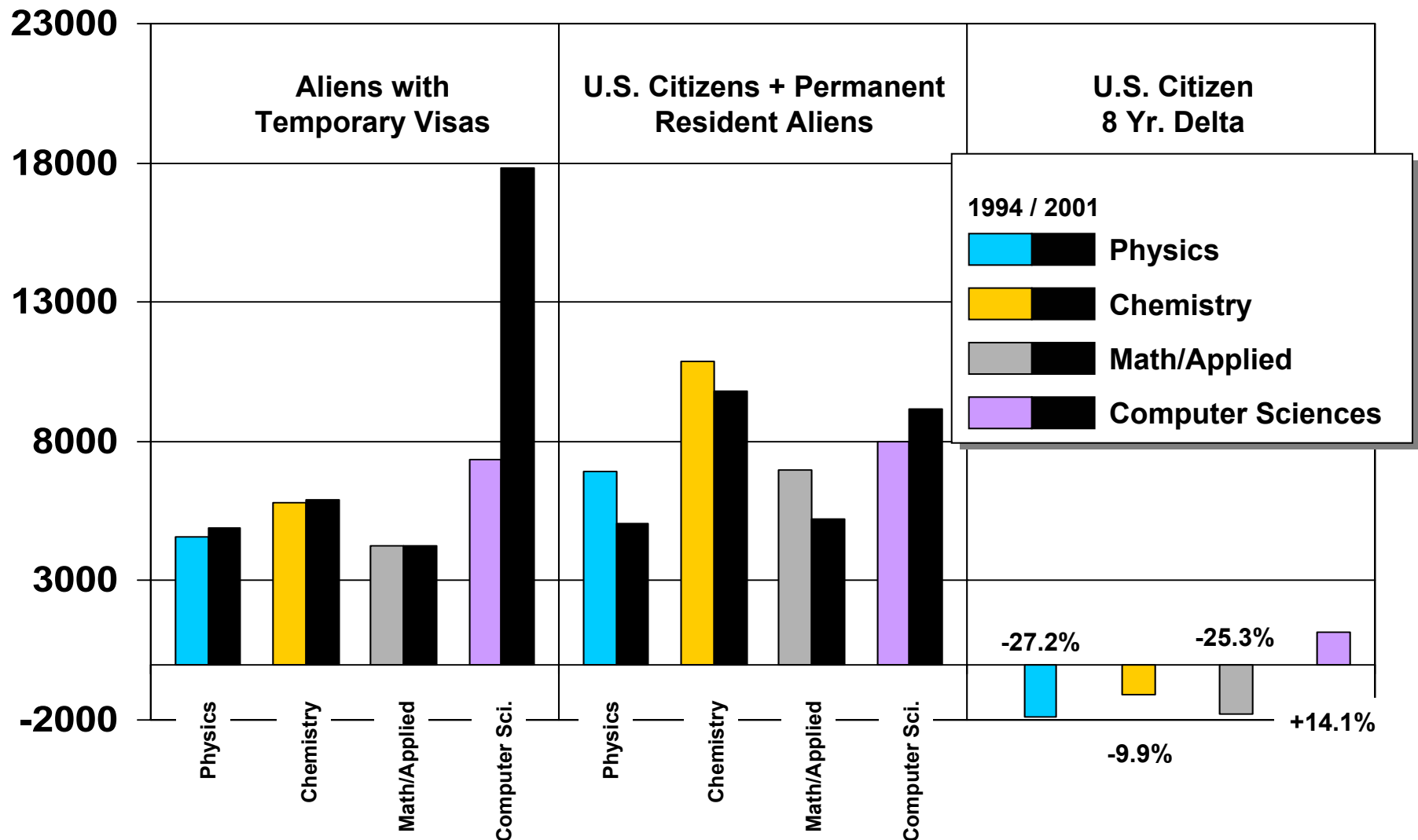
U.S. College and University Graduates, 1966-2001



*Source: Data provided by the NSF, September 2003

U.S. University Trends in Defense-Related S&E Graduate Student Enrollment (1994-2001)

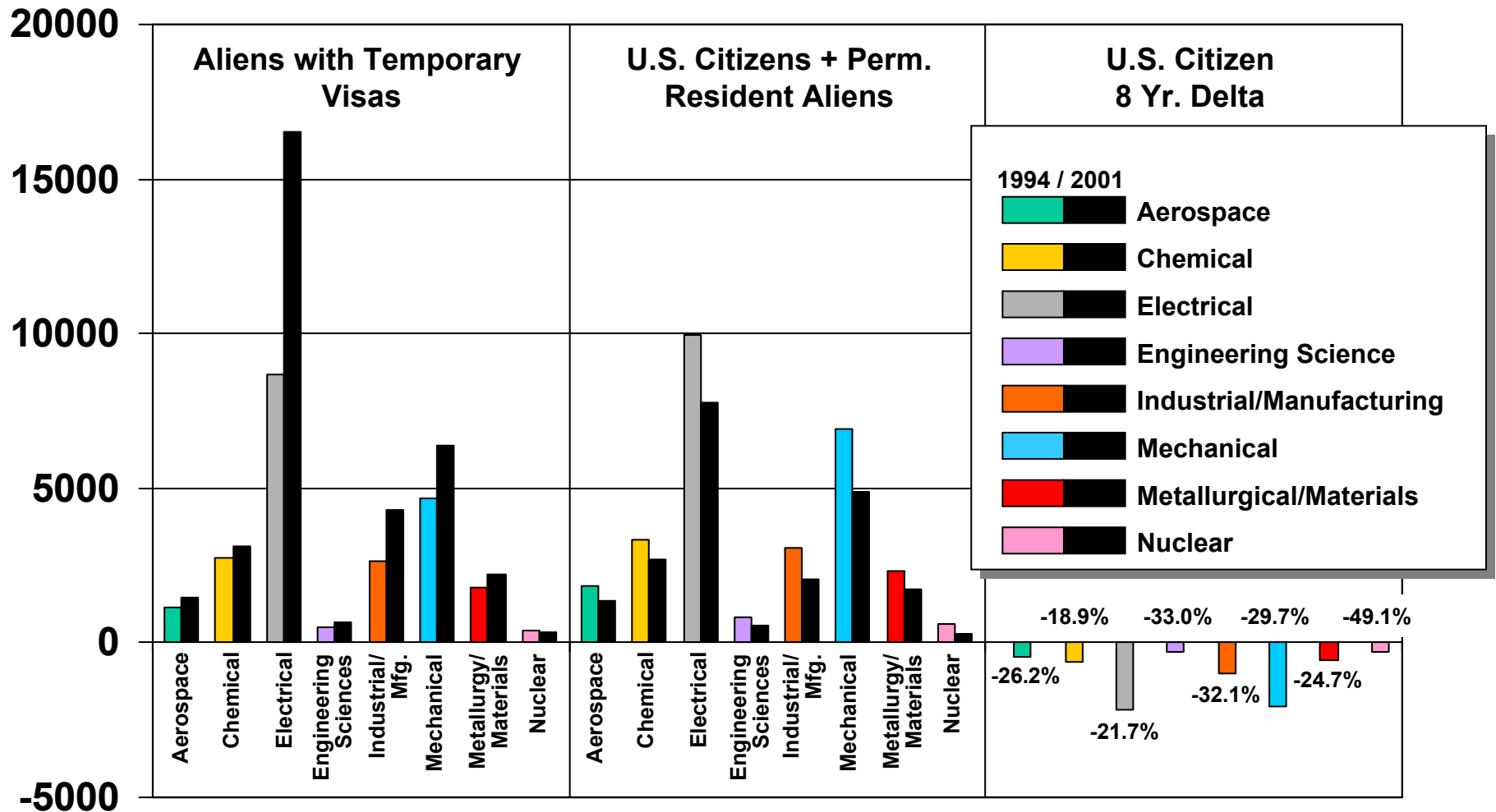
Science Disciplines



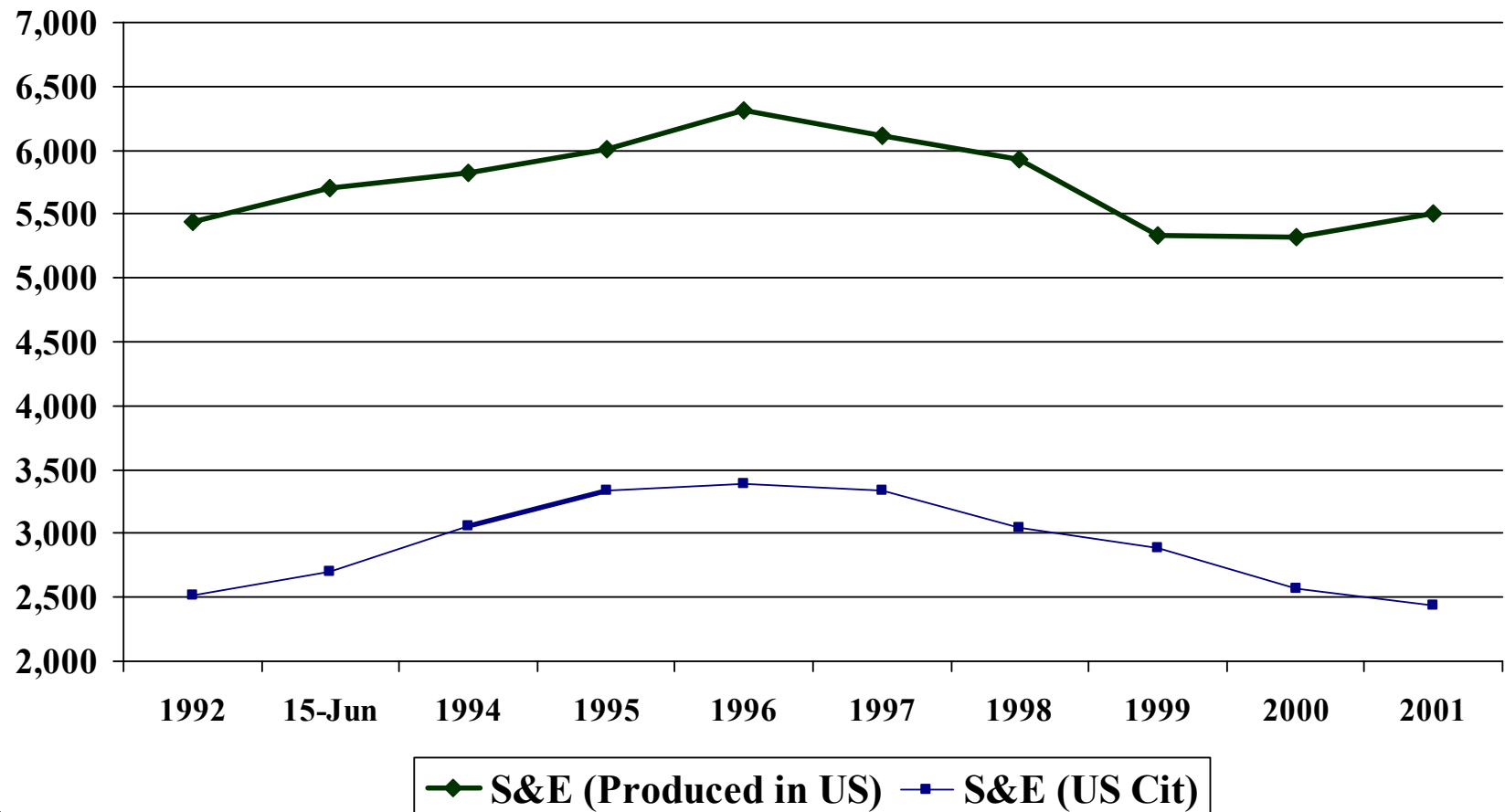
*Source: National Science Foundation – *Graduate Students and Post Doctorates in Science and Engineering*: Fall 2001

U.S. University Trends in Defense-Related S&E Graduate Student Enrollment (1994-2001)

Engineering Disciplines



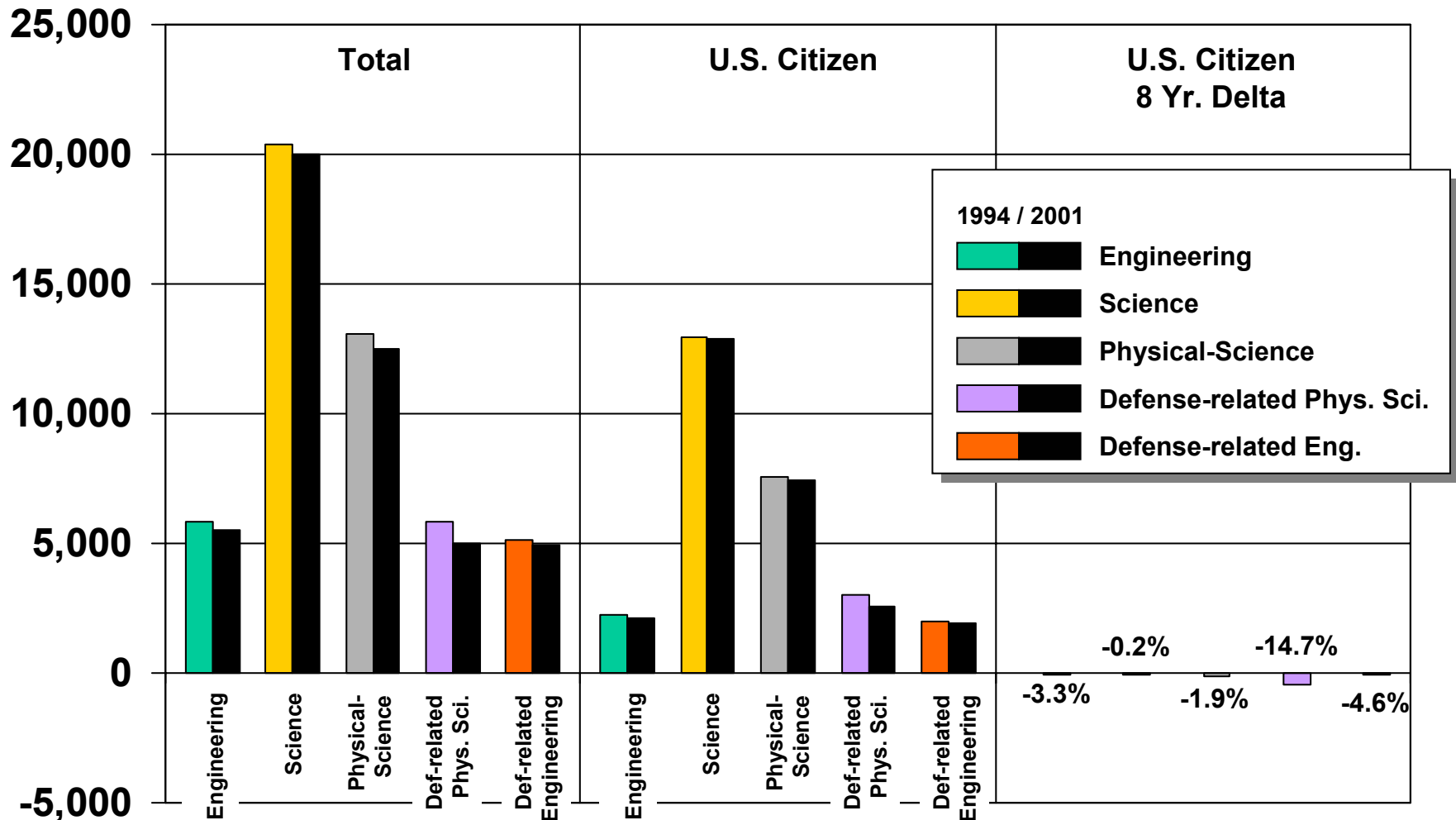
U.S. Engineering PhD's Awarded



*Source: Data provided by the NSF, September 2002

U.S. S&E Ph.D Production Trends (1994-2001)

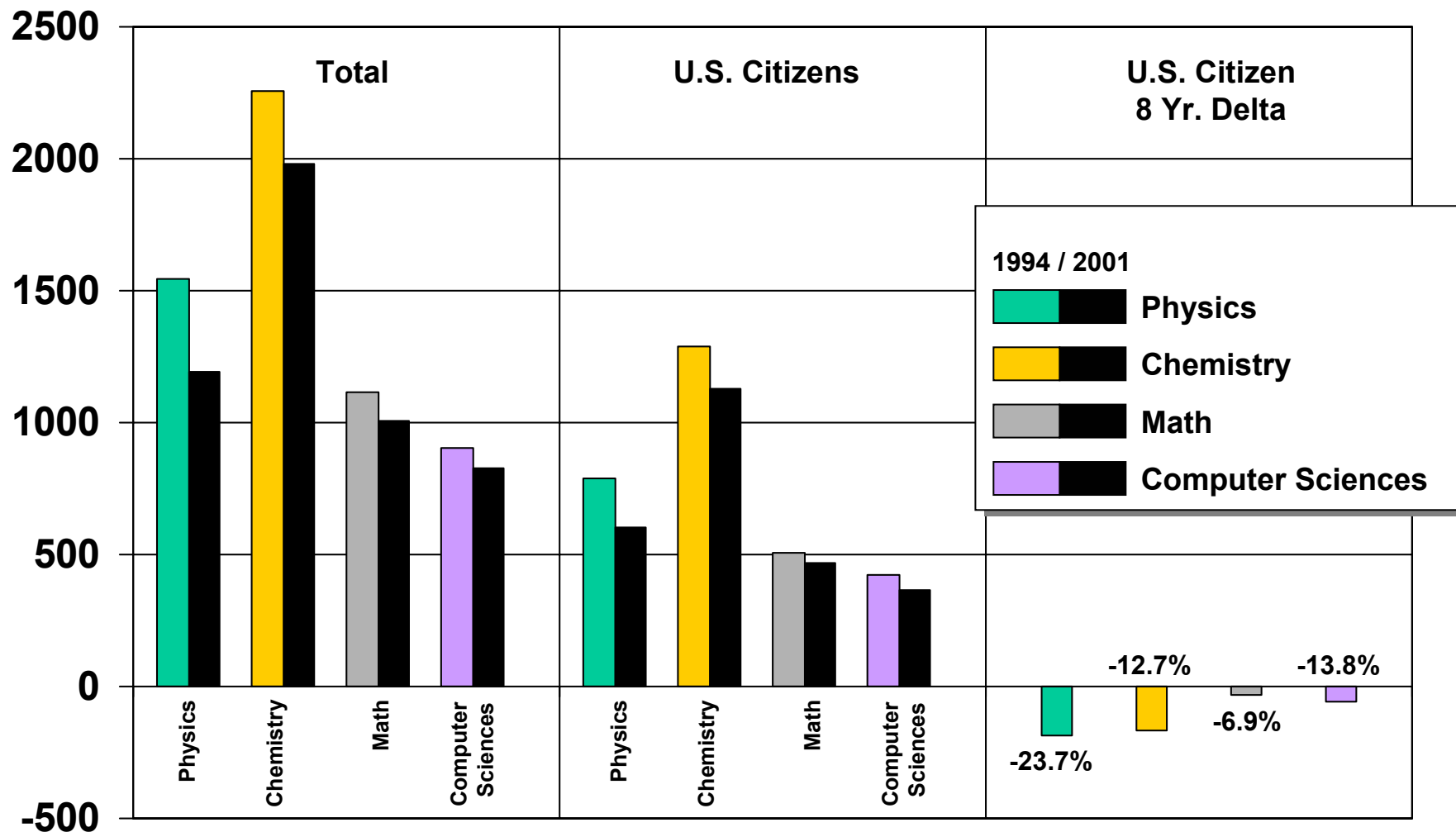
All U.S. S&E Discipline Doctoral Production



*Source: National Science Foundation – *Science and Engineering Doctorate Awards*, 2002

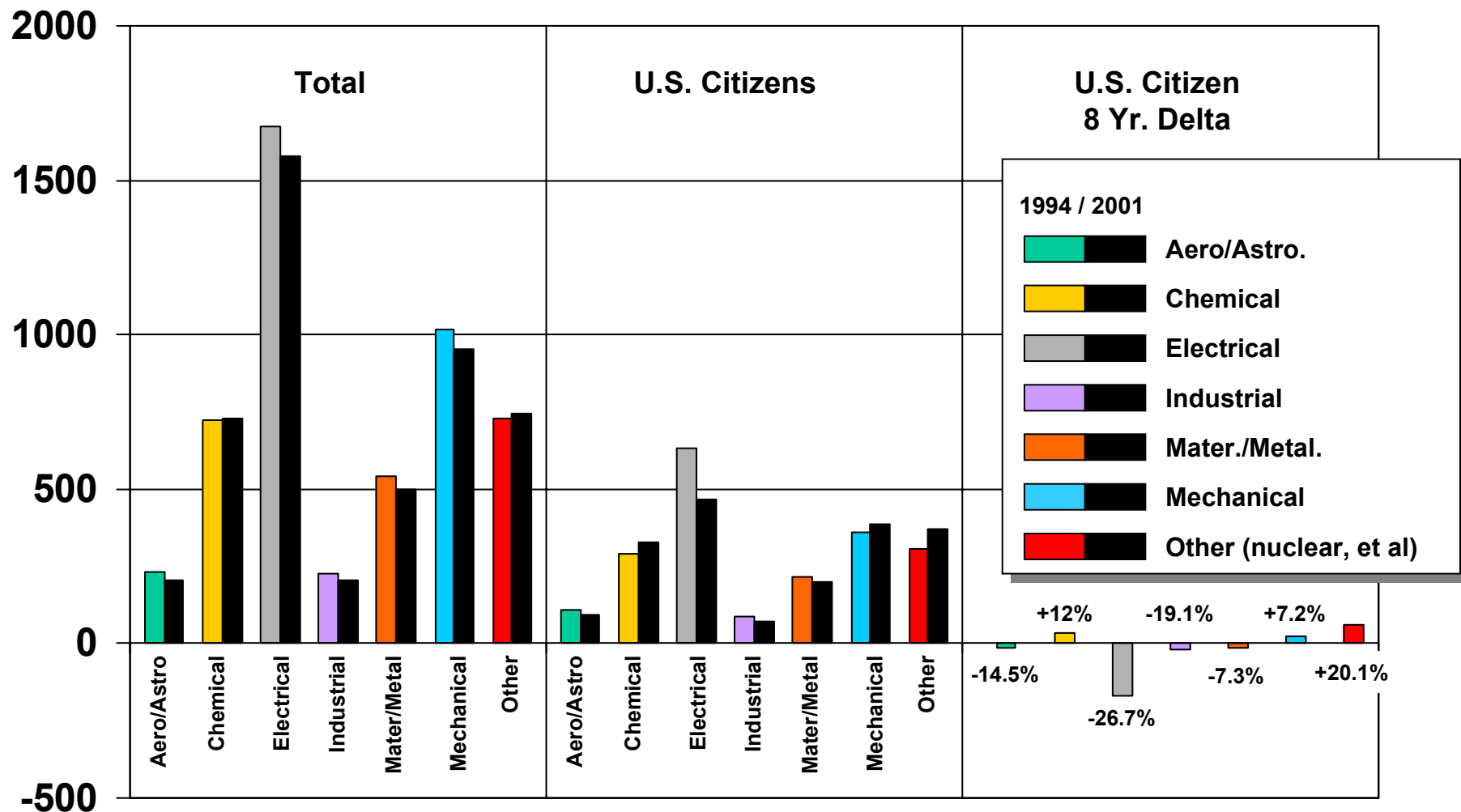
U.S. S&E Ph.D. Production Trends (1994-2001)

Annual U.S. Defense-Related Physical Science Production



U.S. S&E Ph.D. Production Trends (1994-2001)

U.S. Defense-Related Engineering Disciplines Doctoral Production





MS&E: National Security and the Workforce

No Child Left Behind

Existing DoD Outreach and Education Programs

DoD Education Initiatives

Elementary School Level

- **STARBASE**
- **Mentor/Volunteer**
- **Summer Camps**
- **Others**

Middle School Level

- **STARBASE**
- **e-Cybermission**
- **Others**

Secondary School Level

- **Materials World Modules (MWM)**
- **Service Progs.**
- ***Modeling & Simulation-Based Math**
- ***Others TBD (BEST)**
- ***DoD Secondary School Interns (TBD)**

Undergrad Level

- **Undergrad Research**
- **Freshman Science Experience**
- **Service Progs.**
- ***Modeling & Simulation-Based Math**
- ***DoD Undergrad Interns (TBD)**

Graduate Level

- **National Defense Science and Engineering Graduate Fellowships**
- **Service Progs.**
- ***Graduate Research Traineeships**
- ***DoD Graduate Interns (TBD)**

****Exploring***



MS&E: National Security and the Workforce



MWM Content

“Integrated” multidisciplinary approach to Physics, Chemistry, Biology, Environmental Science and Geoscience using “materials as a paradigm”

Kindles interest in science and engineering and instills passion for discovery

- | | | |
|--------------------------|----------------------------|--------------------|
| ➤ Ceramics | ➤ Biodegradable Materials | ➤ Composites |
| ➤ Polymers | ➤ Biosensors | ➤ Concrete |
| ➤ Smart Sensors | ➤ Food Packaging Materials | ➤ Sports Materials |
| ➤ Nanotechnology | ➤ Environmental Catalysis | |
| ➤ Surfaces and Membranes | ➤ Metals and Alloys | |
- *Modules in use*
● *Modules in test*
● *Modules in design*

Deployment Based Considerations of MWM Use:

- *Adopted by DoD Education Activity in 13 overseas school districts in Fall '00*
- *Adopted in over 500 US schools in 14 states*

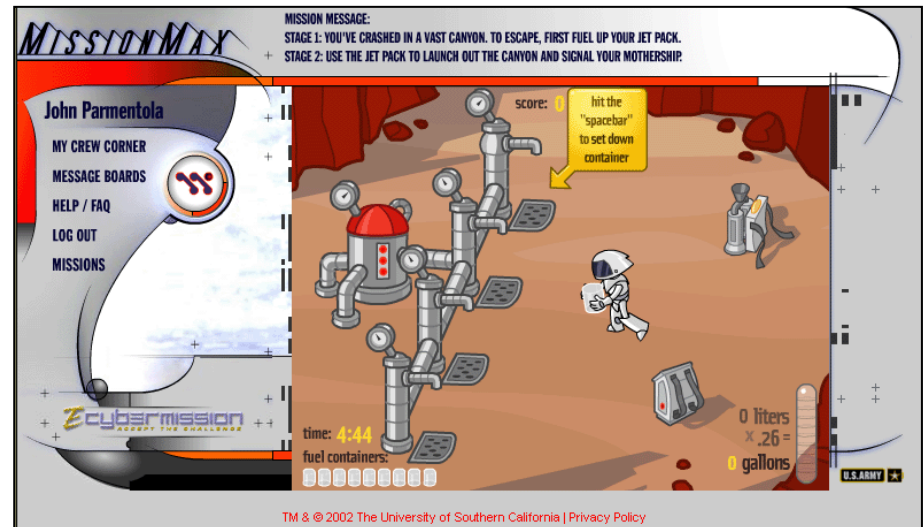




eCYBERMISSION

*Show students that math, science and technology
can be interesting and exciting*

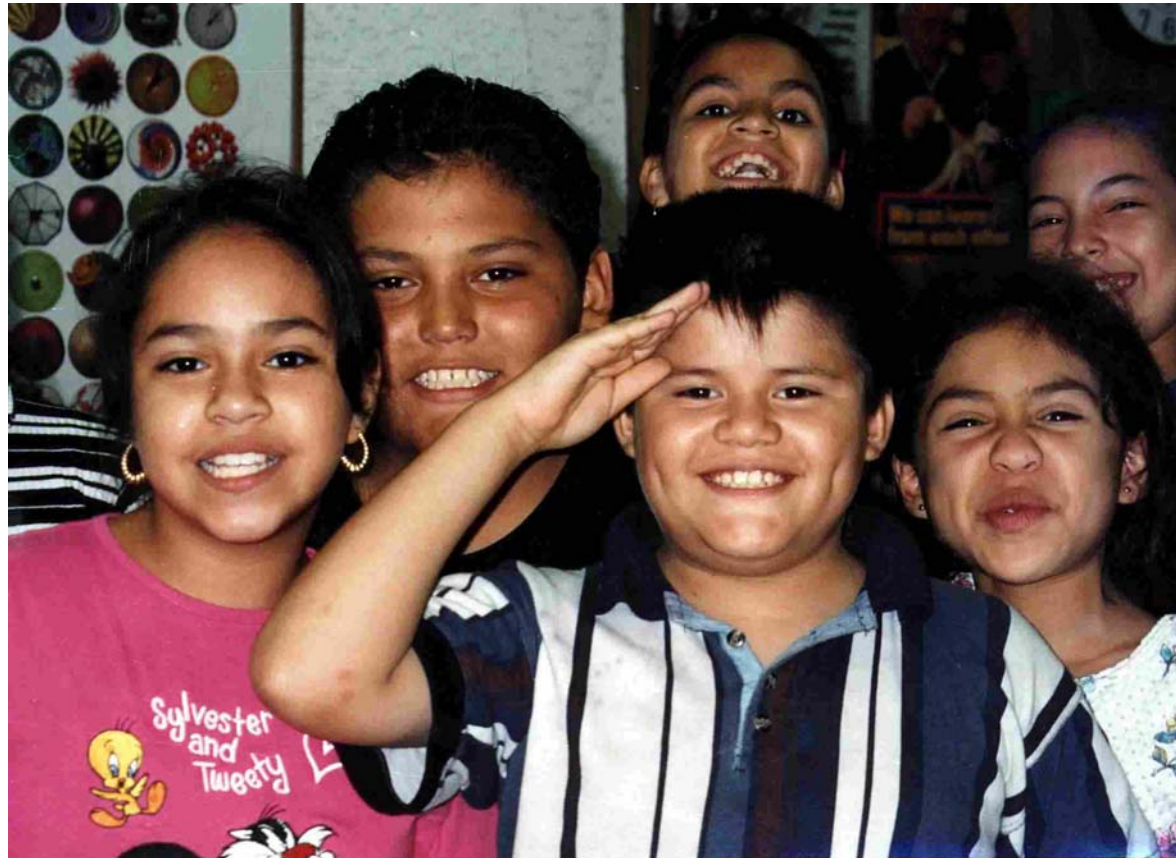
- Vigorously supports Army's intent "to give back to the Nation"
 - Attract an audience of children beyond math/science "stars"
 - Web-based adventure: team competition activities, games, puzzles with solid learning points
- Overview
 - Web Based Competition – Team Effort
 - 6-9th Grade, 3-4 Student Teams + 1 Advisor
 - \$500K in Prizes, (\$2K-\$5K/Team Member) Regional and National





STARBASE

- **Primarily At-Risk kids**
- **20 Classroom Hour experience at DoD bases**
- **45+ sites in 28 states**
- **Engaging Science and Mathematics**
- **Grades 5-8**





Summary

- **U.S. Science and Engineering (S&E) is critical for Defense Transformation**
- **Significant reduction in DoD S&Es over the last decade**
- **More DoD S&Es nearing retirement**
- **U.S. citizens are required in many DoD applications**
- **U.S. S&E workforce is an issue of National Security!**